

DESCRIPTION

GREEN TEA BEVERAGE WITH ENHANCED BITTERNESS

TECHNICAL FIELD

[0001] The present invention relates to a green tea beverage with enhanced bitterness and a method for producing the same. More particularly, this invention relates to a packaged green tea beverage having high-quality bitterness imparted thereto.

BACKGROUND ART

[0002] It is known that caffeine is a bitter substance and tannic acid is an astringent substance (NPL 1). It is said that the bitterness of a green tea beverage is attributed to caffeine or tannins (catechins) and the astringency is to tannins (NPL 2). It is reported that the caffeine contents of various green tea beverages are 160 mg for *Gyokuro* (refined green tea), 20 mg for *Sencha* (brewed green tea), 10 mg for *Kamairi-cha* (pot-roasted green teas), and 20 mg for *Houji-cha* (roasted green tea), per 100 g of green tea beverage, and that the tannins contents of various green tea beverages are 230 mg for *Gyokuro*, 70 mg for *Sencha*, 50 mg for *Kamairi-cha*, and 40 mg for *Houji-cha*, per 100 g of green tea beverage (NPL 3). There is some report stating that when a green tea beverage contains caffeine at a high ratio relative to catechins, the green tea beverage has a pleasant light bitterness (NPL 4).

[0003] In general, in the field of foods and beverages, the “bitterness” is considered as an unpleasant taste quality. There are disclosed many techniques for removing or reducing a food or beverage component having “bitterness” during the process of production of foods or beverages.

[0004] However, the presence of a moderate level of “bitterness” is considered important in some foods and beverages. There are various proposed approaches to increasing the palatability of foods or beverages through controlling the quality of bitterness. For example, it is proposed that an aromatic fruit juice characterized by a faint note of “bitterness” is produced by stably imparting a bitter aftertaste to a fruit juice beverage with the use of ground citrus peels (PTL 1). Also, it is proposed that when the percentage of

co-isohumulone to the total amount of iso- α -acids in a beer-flavored beverage is adjusted to be within a specified range, the lingering bitter aftertaste of the beer-flavored beverage can be reduced while the bitterness perceived at the moment of drinking is retained (PTL 2).

Further, it is reported that in a green tea beverage, catechins give off a bitter top note, and saponins are a class of components that give a lingering bitterness after the top note of catechins (PTL 3).

CITATION LIST

PATENT LITERATURES

- [0005] PTL 1: Japanese Unexamined Patent Application Publication No. JP 2008-212105
PTL 2: Japanese Unexamined Patent Application Publication No. JP 2015-107073
PTL 3: Japanese Unexamined Patent Application Publication No. JP 2013-116052

NON PATENT LITERATURES

- [0006] NPL 1: *Monthly Magazine: Food Chemicals*, 1985, Vol.1, No.6, pp.40-47
NPL 2: *Journal of Japanese Society for Food Science and Technology*, 1975, Vol.2, No.22, pp.59-64
NPL 3: *Standards Tables of Food Composition in Japan - 2015 -* (Seventh Revised Edition)
NPL 4: *Training Course for Nihon-cha Instructors*, 2016, Vol.1, pp.13-16

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0007] People who drink a green tea beverage can enjoy the aroma passing through the nose when the beverage is taken into the mouth, and thereafter can enjoy umami and bitter tastes with taste buds located at the entrance to the larynx. In order to obtain a green tea beverage having high-quality bitterness, the bitterness of the green tea beverage can be adjusted by adding an appropriate amount of caffeine, which is a bitter substance abundant in *Gyokuro*.

[0008] However, when the caffeine content is increased in a packaged green tea beverage that is stored below room temperature for a long period of time, it is more likely that the settlement of lees or precipitates, also called “cream down”, may occur in the beverage,

resulting in the deterioration of the quality of the beverage. Therefore, it is difficult to add high concentrations of the bitter substance caffeine to a packaged green tea beverage.

[0009] In view of the circumstances described above, an object of the present invention is to provide a green tea beverage having high-quality bitterness.

SOLUTION TO PROBLEM

[0010] The present inventors have made intensive studies to achieve the aforementioned object and, as a result, found that when fagomine is added to a green tea beverage, high-quality bitterness can be imparted to the green tea beverage without the need to add caffeine. Thus, the inventors have completed the present invention.

[0011] The present invention includes, but is not limited to, the following embodiments.

- (1) A packaged green tea beverage comprising from 0.01 to 0.8 mg/100 mL of fagomine.
- (2) The beverage as set forth in (1), having a caffeine content of not more than 30 mg/100 mL and a catechins content of not more than 100 mg/100 mL.
- (3) The beverage as set forth in (1) or (2), having a caffeine content of not more than 20 mg/100 mL and a catechins content of not more than 50 mg/100 mL.
- (4) A method for imparting bitterness to a packaged green tea beverage, the method comprising adding fagomine to the beverage at a concentration of from 0.01 to 0.8 mg per 100 mL of the beverage.
- (5) The method as set forth in (4), wherein the beverage has a caffeine content of not more than 30 mg/100 mL and a catechins content of not more than 100 mg/100 mL.
- (6) A method for producing a packaged green tea beverage, the method comprising adding fagomine to the beverage at a concentration of from 0.01 to 0.8 mg per 100 mL of the beverage.
- (7) The method as set forth in (6), wherein the beverage has a caffeine content of not more than 30 mg/100 mL and a catechins content of not more than 100 mg/100 mL.

ADVANTAGEOUS EFFECTS OF INVENTION

[0012] According to the present invention, there can be provided a green tea beverage having high-quality bitterness, more preferably *Gyokuro*-like bitterness.

DESCRIPTION OF EMBODIMENTS

[0013] (Green tea beverage)

One embodiment of the present invention is directed to a green tea beverage comprising from 0.01 to 0.8 mg/100 mL of fagomine. As referred to herein, the “green tea beverage” refers to a beverage prepared by adding a green tea leaf extract, and more specifically, is a generic name for beverages containing a green tea leaf extract obtained from tea leaves -- *i.e.*, tea leaves that are selected from plants of the genus *Camellia* (*e.g.*, the species *Camellia sinensis*) and hybrids thereof, and which are classified as non-fermented tea leaves (*e.g.*, *Sencha* (steamed green tea), *Bancha* (coarse green tea), *Tencha* (non-ground tea leaves used for *Matcha*), *Kamairi-cha* (pot-roasted green teas), *Kukicha* (twig tea), *Bocha* (roasted twig tea), *Mecha* (bud tea)) -- using water, hot water, or an aqueous solution containing an extraction aid. Examples of the species *Camellia sinensis* include *C. sinensis* var. *sinensis* (including the variety *Yabukita*), and *C. sinensis* var. *assamica*. Extraction can be carried out by employing a known method, such as kneader extraction, stirring extraction (batch extraction), countercurrent extraction (drip extraction) or column extraction. Extraction conditions are not particularly limited and can be selected as appropriate depending on the extraction method.

[0014] One preferred embodiment of the green tea beverage of the present invention is a beverage comprising a green tea extract as a primary component. As referred to above, the “beverage comprising a green tea extract as a primary component” refers to a beverage in which the designation of green tea, such as “green tea”, “green tea extract” or the like, is listed high on a list of ingredients labeled in accordance with the Food Labeling Act of Japan (effective on April 2015). Said beverage is preferably a beverage in which the designation of green tea is listed first or second on a list of ingredients, more preferably a beverage in which the designation of green tea is listed first on a list of ingredients.

[0015] A roasted tea beverage, which is prepared with roasted tea leaves obtained by roasting the aforementioned tea leaves classified as non-fermented tea leaves over high heat, has a unique roasted aroma, and a weak bitter taste because of low contents of catechins. In

contrast, the green tea beverage of the present invention is a green tea beverage characterized by having high-quality bitterness imparted thereto. However, there is little need to impart bitterness to a roasted tea beverage, since the roasted tea beverage is characterized by having a weak bitter taste. Thus, in a preferred embodiment, the tea beverage of this invention is not a roasted tea beverage. Examples of roasted tea beverages include, but are not limited to, a liquid consisting solely of an extract from roasted tea leaves, a liquid prepared by mixing an extract from roasted tea leaves as a principle component with an extract from unroasted green tea leaves, or a liquid prepared by adding an additive(s) to such a liquid as mentioned above. As referred to above, the “extract from roasted tea leaves as a principle component” means that the concentration of solids derived from the roasted tea extract is not less than 80% by mass, preferably not less than 90% by mass, based on the solids concentration of the whole extract.

[0016] (Fagomine)

In the present invention, high-quality bitterness is imparted to a green tea beverage by adding fagomine as a bitterness imparting substance. As referred to herein, the term “fagomine” refers to an alkaloid typically isolated from seeds of buckwheat (*Fagopyrum esculentum*), and also referred to as “1,2,5-trideoxy-1,5-epimino-D-xylo-hexitol” (CAS Registry No. 53185-12-9).

[0017] The green tea beverage of the present invention comprises from 0.01 to 0.8 mg/100 mL of fagomine. When the fagomine content in the green tea beverage is not less than 0.01 mg/100 mL, high-quality bitterness can be effectively imparted to the green tea beverage. As referred to herein, the term “high-quality bitterness” refers to a mild bitter aftertaste that lingers after drinking, and is not different from the sharp bitterness perceived at the moment when the beverage is taken into the mouth. To be more specific, the term “aftertaste” refers to “a sensation that lingers in the mouth even when a food is swallowed and the mouth is empty” as defined in JIS Z 8144:2004. The term “mild bitter(ness)” refers to a soft and mild bitter taste perceived as a comfortable afterglow, in contrast to sharp bitterness. Preferred examples of such high-quality bitterness include *Gyokuro*-like

bitterness. The green tea beverage of this invention is characterized by having preferably *Gyokuro*-like bitterness due to the presence of fagomine.

[0018] From the viewpoint that the effects of the present invention can be prominently exhibited, it is preferred that the fagomine content in the tea beverage should be not less than 0.02 mg/100 mL, more preferably not less than 0.03 mg/100 mL. Since the aroma of fagomine may affect the aroma of a green tea beverage, the upper limit of the fagomine content is preferably not more than 0.8 mg/100 mL, more preferably 0.6 mg/100 mL. The fagomine content in the beverage can be measured using liquid chromatography/tandem mass spectrometry (LC-MS/MS).

[0019] The origin of fagomine as used in the present invention is not particularly limited as long as it is commonly used in the food and beverage field -- for example, both chemically synthesized and extracts from fagomine-containing plants can be used. In the case of using a plant extract, it is preferable to use a purified product (including a crudely purified product) of fagomine for the purpose of minimizing its effect on the aroma of a green tea beverage.

[0020] (Caffeine)

The green tea beverage of the present invention is characterized in that by addition of fagomine, high-quality bitterness similar to a caffeine-rich green tea beverage like *Gyokuro* can be imparted to the green tea beverage. The green tea beverage of this invention may not necessarily contain caffeine. However, a green tea beverage containing caffeine will have a more similar bitterness to *Gyokuro*, since fagomine increases the bitterness of caffeine. Therefore, from the viewpoint that the action and effect of this invention are significantly exhibited, the green tea beverage of this invention has a caffeine content of preferably not less than 0.1 mg/100 mL, more preferably not less than 1 mg/100 mL, still more preferably not less than 3 mg/100 mL. Caffeine is generally present in green tea extracts. Therefore, it is not necessary to decaffeinate a green tea extract used in this invention. Exemplary decaffeination treatments include treatments of a green tea extract by contact with activated clay or acid clay. However, extremely high caffeine content, combined with the bitterness of fagomine, is apt to deteriorate high-quality

bitterness. Further, in the case of a packaged green tea beverage intended for long-term storage, extremely high caffeine content can be causative of the occurrence of cream down. From the aforementioned viewpoints, it is preferred that the green tea beverage of this invention should have a caffeine content of not more than 30 mg/100 mL, more preferably not more than 25 mg/100 mL, still more preferably not more than 20 mg/100 mL. The caffeine content in the beverage can be measured using high-performance liquid chromatography (HPLC).

[0021] (Other components)

In addition to the aforementioned components, various additives including antioxidant and pH adjustor can be added to the green tea beverage of the present invention. A packaged green tea beverage comprising a liquid green tea extract, fagomine, an antioxidant, and a pH adjustor has *Gyokuro*-like aroma, and is one of preferred embodiments of this invention. The packaged green tea beverage has a pH of preferably from about 5.5 to 7.0, more preferably from about 5.8 to 6.5. As referred to herein, the pH refers to a value of pH as measured by a pH meter on 100 mL of a liquid sample weighed out in a 300 mL beaker and adjusted to a temperature of 20°C.

[0022] In contrast, it is preferred that the green tea beverage of the present invention should not contain a component that may impair the effect of this invention. Examples of the component that may impair the effect of this invention include components that reduce the bitterness imparted by fagomine, and bittering agents with a lingering strong bitter taste that may affect the mild bitterness of fagomine. To be specific, examples of bitterness reducing components include cyclodextrin (also called “cyclic oligosaccharide”), and exemplary bittering agents with a lingering strong bitter taste include saponins (including tea leaf saponin extracted and purified from tea leaves). Other examples of components that may impair the effect of this invention include sweeteners. Examples of sweeteners include: natural sweeteners, such as fructose, sugar, fructose-glucose syrup, glucose, maltose, sucrose, high-fructose syrup, sugar alcohol, oligosaccharide, honey, sugarcane squeeze (brown sugar syrup), starch syrup, stevia powder, stevia extract, *Momordica grosvenori* powder,

Momordica grosvenori extract, licorice (*Glycyrrhiza glabra*) powder, licorice extract, *Thaumatococcus daniellii* seed powder, and *Thaumatococcus daniellii* seed extract; and artificial sweeteners, such as acesulfame-K, sucralose, neotame, aspartame, and saccharin.

[0023] When a sweetener is added to impart sweetness to a green tea beverage, enhancement of high-quality bitterness by fagomine becomes less perceivable. Thus, from the viewpoint that the action and effect of the present invention can be significantly exhibited, a beverage with a low degree of sweetness is one of preferred embodiments of the green tea beverage of this invention. As referred to herein, the beverage with a “low degree of sweetness” refers specifically to a beverage having a degree of sweetness of not more than 2, preferably not more than 1.5, more preferably not more than 1, still more preferably not more than 0.5. As referred to above, the “degree of sweetness” is a measure of the intensity of sweetness, and is expressed as a relative ratio of the sweetness of a beverage to that of 1 wt.% sucrose (at 20°C), which is taken as 1. The degree of sweetness of a beverage can be determined by converting the content (percent concentration by weight) of each sweetness component contained in the beverage into a sucrose equivalent based on the relative ratio of the sweetness of each sweetness component to that of sucrose, which is taken as 1, and then by totaling the sucrose sweetness equivalents of all sweetness components contained in the beverage. The relative ratios of the sweetness of different sweetness components to that of sucrose, which is taken as 1, can be determined using a known sugar sweetness conversion table (e.g., McMurry J., *Organic Chemistry*, 7th edition, p.988). A preferred example of green tea beverages with a low degree of sweetness is a green tea beverage having no sweetness component added thereto.

[0024] Other known bitter components in green tea beverages include catechins. Catechins are components perceived as sharp bitterness and astringency at the moment when a beverage is taken into the mouth. In a green tea beverage containing high concentrations of catechins, the effect of the present invention, which is enhancement of only a high-quality bitter aftertaste without enhancement of sharp bitterness perceived at the moment when a beverage is taken into the mouth, can hardly be obtained. Therefore, the catechins content

in the green tea beverage of this invention is preferably not more than 100 mg/100 mL, more preferably not more than 80 mg/100 mL, still more preferably not more than 70 mg/100 mL, particularly preferably not more than 60 mg/100 mL, extraordinarily preferably not more than 50 mg/100 mL. As referred to herein, the term “catechins” is a generic term for catechin, epicatechin, gallocatechin, epigallocatechin, catechin gallate, epicatechin gallate, gallocatechin gallate, and epigallocatechin gallate. The catechins content is defined based on a total amount of the aforementioned eight types of catechins. The catechins content in the beverage can be measured by high-performance liquid chromatography (HPLC).

[0025] (Packaged green tea beverage)

According to the present invention, high-quality bitterness can be imparted to a green tea beverage while the occurrence of cream down is suppressed. From this viewpoint, a packaged green tea beverage that is stored below room temperature for a long period of time is one of preferred embodiments of the green tea beverage of this invention. The package used for the packaged green tea beverage of this invention can be any of known packages used for common beverages. For example, a resin package, a metal package, a paper package, a glass package, or the like can be advantageously used. In one embodiment, the packaged green tea beverage can be provided in a form packed and sealed in, for example, a molded package mainly made of polyethylene terephthalate (so-called PET bottle), a metal can, a paper package combined with a metallic foil or plastic film, or a glass bottle. The volume of the green tea beverage of this invention is not particularly limited, and is for example in the range of from 100 mL to 3000 mL, preferably from 350 mL to 2000 mL, more preferably from 500 to 1000 mL.

EXAMPLES

[0026] Hereunder, the present invention will be specifically described in detail by way of experimental examples, but this invention is not limited to these examples. Unless otherwise stated herein, all numerical ranges are inclusive of their endpoints.

[0027] Quantification of different components

Fagomine, caffeine, and catechins present in different samples were quantified

according to the procedures detailed below.

[0028] (1) Fagomine

Analysis of fagomine in green tea beverage samples was performed using liquid chromatography/tandem mass spectrometry (LC-MS/MS). Green tea beverage samples were vacuum concentrated, if necessary, before analysis.

LC-MS/MS measurement conditions

- Column: TSKgel Amide-80, ϕ 4.6 mm $\times$ 250 mm, particle size 5 μ m
- Mobile phase: Mixed solution of water, acetonitrile and acetic acid
- Flow rate: 1.0 mL/min.
- Column temperature: 40°C
- Ionization method: Electrospray ionization (positive ion detection mode)
- Mass-to-charge ratio (m/z): 147.9 $\rightarrow$ 85.9

[0029] (2) Caffeine and catechins

A green tea beverage was filtered by a filter (0.45 μ m) and quantified using reference standards (standard samples) by HPLC (high-performance liquid chromatography). Quantification of caffeine was carried out using a reference standard of caffeine (produced by FUJIFILM Wako Pure Chemical Corporation). Quantification of catechins was carried out using reference standards of catechin, epicatechin, gallocatechin, epigallocatechin, catechin gallate, epicatechin gallate, gallocatechin gallate, and epigallocatechin gallate (Kurita high-purity reagents).

HPLC analysis conditions

- HPLC system: Tosoh HPLC system LC8020 model II
- Column: TSKgel ODS80T sQA (4.6 mm $\times$ 150 mm)
- Column temperature: 40°C
- Mobile phase A: Water/acetonitrile/trifluoroacetic acid (90:10:0.05)
- Mobile phase B: Water/acetonitrile/trifluoroacetic acid (20:80:0.05)
- Detection: UV 275 nm
- Injection volume: 20 μ L

- Flow rate: 1 mL/min.

- Gradient program:

Time (min.)	%A	%B
0	100	0
5	92	8
11	90	10
21	90	10
22	0	100
29	0	100
30	100	0

[0030] Experiment 1: Production and evaluation of green tea beverages

Ten grams of *Gyokuro* tea leaves were extracted with 60 mL of hot water at 60°C for 2.5 minutes, and then separated out, whereby a green tea (*Gyokuro*) beverage (Sample 1-1) was obtained.

[0031] Likewise, a base green tea beverage (Sample 1-2) was prepared using heavily fired *Sencha* tea leaves as a source ingredient. Next, fagomine (produced by Funakoshi Co., Ltd.; purity: 98%) was added to the base green tea beverage (Sample 1-2) to thereby produce different packaged green tea beverages containing caffeine, fagomine and catechins in different amounts as indicated in the table given below (pH: about 6.0).

[0032] Also, catechins (produced by Funakoshi Co., Ltd.; purity: 98%) were added to Sample 1-2 to thereby produce different green tea beverages containing high concentrations of catechins (Samples 1-17, 1-18). The catechins added to the green tea beverages of Samples 1-17 and 1-18 were about 20% epicatechin, about 40% epigallocatechin, about 10% epicatechin, about 20% catechin, and about 10% epicatechin gallate.

[0033] The produced green tea beverages were subjected to sensory evaluation for bitterness by five professional panelists. By reference to Samples 1-1 and 1-2, which were rated as 5 points and 1 point, respectively, regarding a bitter aftertaste perceived after drinking, the ratings given by each panelist based on the following criteria were discussed

again in a free-form manner among all the panelists, and the final ratings were assigned as integer values in consensus among them.

- 5 points: High-quality bitterness is very strongly perceived (similar to Sample 1-1)
- 4 points: High-quality bitterness is strongly perceived
- 3 points: High-quality bitterness is perceived
- 2 points: High-quality bitterness is slightly perceived
- 1 point: High-quality bitterness is not perceived (similar to Sample 1-2)

[0034] The sensory evaluation results are shown in Table 1. When fagomine was added to green tea beverages, no change was observed in the bitterness perceived at the moment when the beverage was taken into the mouth, but high-quality bitterness became noticeable as an aftertaste after drinking. Additionally, with regard to Sample 1-16, which had a fagomine content of 1 mg/100 mL, addition of high-quality bitterness was observed, but the astringency of fagomine was also perceived so that the palatability of the green tea beverage was decreased. Further, although the aftertaste ratings for Samples 1-14 and 1-15 were both the same, *i.e.* 5 points, some panelists reported that the astringency of fagomine was slightly perceived in Sample 1-15.

[0035] With regard to the green tea beverages (Samples 1-17, 1-18) having a catechins content adjusted to 50 mg/100 mL or 200 mg/100 mL, sharp astringency became strongly perceived immediately upon drinking, but no change was observed in the aftertaste (high-quality bitterness) perceived after drinking. In other words, when the concentration of catechins was merely increased without addition of fagomine, high-quality bitterness like *Gyokuro* was not imparted successfully to green tea beverages.

[0036] [Table 1]

Sample	1-1	1-2	1-3	1-4	1-5	1-6
Caffeine content (mg/100 mL)	160	10	10	10	10	10
Fagomine content (mg/100 mL)	0	0	0.005	0.01	0.02	0.03
Catechins content (mg/100 mL)	230	33	33	33	33	33
Bitter aftertaste rating	5	1	2	3	4	5

Sample	1-7	1-8	1-9	1-10	1-11	1-12
Caffeine content (mg/100 mL)	10	10	10	10	10	10
Fagomine content (mg/100 mL)	0.05	0.08	0.1	0.15	0.2	0.25
Catechins content (mg/100 mL)	33	33	33	33	33	33
Bitter aftertaste rating	5	5	5	5	5	5

Sample	1-13	1-14	1-15	1-16	1-17	1-18
Caffeine content (mg/100 mL)	10	10	10	10	10	10
Fagomine content (mg/100 mL)	0.3	0.5	0.8	1	0	0
Catechins content (mg/100 mL)	33	33	33	33	50	200
Bitter aftertaste rating	5	5	5	5	1	1

[0037] Experiment 2: Production and evaluation of green tea beverages

Experiment 2-1

Fagomine (produced by Funakoshi Co., Ltd.; purity: 98%) was added to a base green tea beverage (Sample 2-1) produced mainly with heavily fired *Sencha*, to thereby produce different green tea beverages containing caffeine, fagomine and catechins in different amounts as indicated in the table given below (pH: about 6.0).

[0038] The produced green tea beverages were subjected to sensory evaluation for bitterness by following the same procedure as in Experiment 1, except that Sample 1-1, which was used in Experiment 1 and rated as 5 points, and Sample 2-1, which was rated as 1 point, were used as reference samples.

[0039] The sensory evaluation results are shown in the table given below. As in Experiment 1, when fagomine was added to green tea beverages, no change was observed in the bitterness perceived at the moment when the beverage was taken into the mouth, but high-quality bitterness became noticeable as an aftertaste after drinking. Additionally, with regard to Sample 2-9, which had a fagomine content of 1 mg/100 mL, addition of high-quality bitterness was observed, but the astringency of fagomine was also perceived so that the palatability of the green tea beverage was decreased.

[0040] [Table 2-1]

Sample	1-1	2-1	2-2	2-3	2-4	2-5	2-6	2-7	2-8	2-9
Caffeine content (mg/100 mL)	160	18	18	18	18	18	18	18	18	18
Fagomine content (mg/100 mL)	0	0	0.01	0.02	0.03	0.1	0.2	0.3	0.8	1
Catechins content (mg/100 mL)	230	46	46	46	46	46	46	46	46	46
Bitter aftertaste rating	5	1	3	4	5	5	5	5	5	5

[0041] Experiment 2-2

Different packaged green tea beverages were produced and evaluated by following the same procedures as in Experiment 2-1, except that caffeine (reagent) was added to adjust the beverages to a caffeine content of 28 mg/100 mL.

[0042] The sensory evaluation results are shown in the table given below. Also in the case

where fagomine was added to green tea beverages containing caffeine at a concentration of 28 mg per 100 mL of the beverage, the produced green tea beverages had high-quality bitterness.

[0043] [Table 2-2]

Sample	1-1	2-10	2-11	2-12	2-13
Caffeine content (mg/100 mL)	160	28	28	28	28
Fagomine content (mg/100 mL)	0	0	0.01	0.02	0.30
Catechins content (mg/100 mL)	230	46	46	46	46
Bitter aftertaste rating	5	1	3	4	5

[0044] Experiment 2-3

Different packaged green tea beverages were produced and evaluated by following the same procedures as in Experiment 2-1, except that catechins (produced by Funakoshi Co., Ltd.) were added to adjust the beverages to a catechins content of 90 mg/100 mL.

[0045] The sensory evaluation results are shown in the table given below. Green tea beverages having high-quality bitterness were successfully produced by addition of fagomine.

[0046] [Table 2-3]

Sample	1-1	2-14	2-15	2-16	2-17
Caffeine content (mg/100 mL)	160	18	18	18	18
Fagomine content (mg/100 mL)	0	0	0.01	0.02	0.30
Catechins content (mg/100 mL)	230	90	90	90	90
Bitter aftertaste rating	5	1	3	4	5

[0047] Experiment 2-4

Different packaged green tea beverages were produced and evaluated by following the same procedures as in Experiment 2-1, except that caffeine and catechins were added to adjust the beverages to a caffeine content of 28 mg/100 mL and a catechins content of 90 mg/100 mL.

[0048] The sensory evaluation results are shown in the table given below. Green tea beverages having high-quality bitterness were successfully produced by addition of fagomine.

[0049] [Table 2-4]

Sample	1-1	2-18	2-19
Caffeine content (mg/100 mL)	160	28	28
Fagomine content (mg/100 mL)	0	0	0.30
Catechins content (mg/100 mL)	230	90	90
Bitter aftertaste rating	5	1	4

[0050] Experiment 3: Production and evaluation of green tea beverages

A commercially available decaffeinated green tea beverage (Sample 3-1) was used as a base green tea beverage (produced with *Sencha* tea leaves as a source material). In this experiment, fagomine (produced by Funakoshi Co., Ltd.; purity: 98%) was added to the base green tea beverage to thereby produce different green tea beverages containing caffeine, fagomine and catechins in different amounts as indicated in the table given below (pH: about 6.0).

[0051] The produced green tea beverages were subjected to sensory evaluation for bitterness by following the same procedure as in Experiment 1, except that Sample 1-1, which was used in Experiment 1 and rated as 5 points, and Sample 3-1, which was rated as 1 point, were used as reference samples.

[0052] The sensory evaluation results are shown in Table 3. When fagomine was added to

green tea beverages, no change was observed in the bitterness perceived at the moment when the beverage was taken into the mouth, but high-quality bitterness became noticeable as an aftertaste after drinking. However, it was found that since the samples produced in this experiment contained no caffeine, enhancement of a bitter aftertaste by fagomine was less significant in these samples than in Sample 1-11 in Experiment 1 and Sample 2-6 in Experiment 2, both of which had the same fagomine content.

[0053] [Table 3]

Sample	1-1	3-1	3-2
Caffeine content (mg/100 mL)	160	0	0
Fagomine content (mg/100 mL)	0	0	0.2
Catechins content (mg/100 mL)	230	30	30
Bitter aftertaste rating	5	1	4

CLAIMS

1. A packaged green tea beverage comprising from 0.01 to 0.8 mg/100 mL of fagomine.
2. The beverage according to claim 1, having a caffeine content of not more than 30 mg/100 mL and a catechins content of not more than 100 mg/100 mL.
3. The beverage according to claim 1 or 2, having a caffeine content of not more than 20 mg/100 mL and a catechins content of not more than 50 mg/100 mL.
4. A method for imparting bitterness to a packaged green tea beverage, the method comprising adding fagomine to the beverage at a concentration of from 0.01 to 0.8 mg per 100 mL of the beverage.
5. The method according to claim 4, wherein the beverage has a caffeine content of not more than 30 mg/100 mL and a catechins content of not more than 100 mg/100 mL.
6. A method for producing a packaged green tea beverage, the method comprising adding fagomine to the beverage at a concentration of from 0.01 to 0.8 mg per 100 mL of the beverage.
7. The method according to claim 6, wherein the beverage has a caffeine content of not more than 30 mg/100 mL and a catechins content of not more than 100 mg/100 mL.